Random Thoughts about Tracking

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- STAR Tracking: success and limitations
- Lessons from TPC + Silicon system
- My own remarks on sPHENIX tracking

Disclaimer: Purely a view as a physicist. Minimal technical details.

STAR Tracking

Offline Tracking – Sti package

Hits are ordered according to layers (ordered according to radius)
- Not able to perform tracking with forward station-like tracking*

Track search starting from outmost layer, propagate inwards,
seeding: simple combinations or CA
After a seed is established, perform following-the-track propagation (with Kalman) inwards to add more hits

When multiple hits are inside the search window, keep all and perform tree-like search inwards, finally find the best track candidate (chi2 fit or other quality)

Tracking material built separately – consistency with GEANT
- simple geometry volumes (barrel, tube, plane etc.)

TPC + Silicon detectors/HFT (4 layers)
- using the same integrated tracking, outside-inside search means TPC tracks first then attach HFT hits to tracks

*Addressed in another tracking package – Stv

Specific Issues

Related to silicon detectors:

0) Standard alone tracking? Not pursued
- only 4 layers (SSD layer has many inactive channels)
- PXL inner layer has many background hits
  30:70 (AuAu central signal hits : background hits from pileup MB and UPC)

1) Matching ordering: no specific order in STAR
consideration: high p tracks first? primary tracks first?

2) Material (active + inactive) and Mis-alignment
not so friendly to handle the detector mis-alignment

3) Noise/background hits
for sPHENIX MAPS, the pileup level will be significantly reduced (4 μs vs. 186 μs)

4) Track silicon hit requirement
default require three layer of silicon hits for background reason
lose the acceptance for weak decay particles (Ks, Lambda etc.)

Vertexing:

Global tracks ->(no further tracking) primary vertex -> primary track refitting

Or

Tracking for primaries first -> then re-search tracks for secondaries (may tune for weak-decays)

Hit Density on MAPS at RHIC Environment

Simulation@50kHz

	PXL inner	PXL outer
Radius (cm)	2.8	8
MB pileup hits (cm^{-2})	13	~3
UPC electrons (cm^{-2})	33	~3
Total bkgd hits (cm^{-2})	46	~6
MB signal Au+Au (cm^{-2})	~8	~1
Au+Au MB real data (cm^{-2})	~50	~5

First layer detector	**MAPS @ SPHENIX**	**PXL at STAR**
RHIC luminosity	100kHz	50kHz
Radius (cm)	2.3	2.8
Integration time (μs)	4	186
Total bkgd hits (cm^{-2})	~2-3	46

The background hit fraction in MB triggered AuAu events can be ~30% at first layer of MAPS at sPHENIX

Remarks

1) Local method for track finder: Local Kalman filter or CA
- better be parallelized, can apply the same algorithm for both offline and online?

2) Pay attention how to organize the tracking algorithm
- do radial tracker finder only or want to keep the ability for future forward tracking

3) Given the significant difference in hit errors/material/background between TPC and silicon detectors, it is better to run tracking for TPC hits first, then connect TPC tracks to silicon hits.
- convenient for monitoring TPC calibrations
- allow standard alone tracking from silicon detectors
- special attention to silicon hit pattern requirement considering background level, fake match rate etc.

4) Track search ordering:
- STAR's approach was before precision silicon detector era
- may use ALICE's approach
  - high pT tracks first, primary tracks first